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EFFICIENCY OF GAINS AND CARCASS CHARACTERISTICS OF SWINE OF TWO DEGREES OF FATNESS SLAUGHTERED AT THREE WEIGHTS[1]

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Summary

Two hundred barrows and gilts were slaughtered at 100, 113 and 127 kg live weight. The sample was comprised of 36 litters, of which six litters within each breed of sire (Duroc, Hampshire and Yorkshire) were classified as fat litters (2.36 cm) and six litters classified as lean litters (2.16 cm) on the basis of litter mean backfat probes taken at 68 kg live weight.

Growth traits were evaluated from 9 weeks of age until the designated slaughter weight. Carcasses from the first replication (18 litters) were evaluated for percentage separable lean, fat and bone and those from the second replication (18 litters) were evaluated for percentage closely trimmed lean cuts.

The fat and lean groups had similar carcass length, *longissimus* muscle area and percentage closely trimmed lean cuts. The fat group had significantly thicker backfat, lower percentage separable lean and a higher percentage separable fat than the lean group.

The three weight groups tended to have similar average daily gains and feed efficiencies for the total test period. As slaughter weight increased from 100 to 127 kg there was an increase in carcass backfat thickness (P<.05) and *longissimus* muscle area (P<.01). Percentage separable lean, fat and bone of carcass were similar at each of the three slaughter weights. The 127 kg group tended to have lower percentages closely trimmed lean cuts than the 100 and 113 kg groups which had similar percentages. The effect of slaughter weight on growth and carcass traits in this study differ from findings reported earlier for swine of different genetic background.

(Key Words: Feeding Efficiency, Carcass, Fat, Weight, Swine.)

Introduction

At present, the majority of slaughter hogs in the United States are marketed between 100 and 110 kg live weight. Feeding hogs to heavier weights increases the total weight of product per litter and reduces the number of animals required to produce the same market weight. However, whether or not hogs should be carried to heavy weights depends on the efficiency of growth to heavy weights, on changes in carcass composition as slaughter weight increases and on consumer acceptance. There has been limited research in the past to evaluate growth and carcass characteristics of hogs of different degrees of fatness when fed to heavier weights.

This study was conducted to measure feeding efficiency, rates of gain and certain carcass characteristics in swine of two degrees of fatness slaughtered at live weights of 100, 113 and 127 kilograms.

Materials and Methods

Growth and carcass data were collected on 200 barrows and gilts, representing 36 litters, that were three-quarters Duroc, Hampshire or Yorkshire breeding. Litters were produced by backcrossing two-breed cross dams to purebred boars. The pigs were farrowed during the 1975 fall (replication 1) and 1976 spring (replication 2) farrowing seasons in the Southwest Livestock and Forage Research Station swine facilities.

All pigs were weaned at 6 weeks and moved to the finishing unit at approximately 8 weeks of age. Each season, six litters by each breed of

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sire were randomly chosen and fed in litter groups of six pigs per pen. Pigs within litters were selected to keep the sex ratio as equal as possible, and were fed in solid concrete floor pens with free access to feed and water. After an adjustment period of 1 week, the pigs were weighed and placed on test. Diets fed were milo (replication 1) or wheat (replication 2) supplemented with soybean meal to give calculated protein percentages of 16%, fed to 50 kg live weight; or 14%, fed from 50 kg to the end of test. Diets were also supplemented to meet NRC requirements for minerals and vitamins.

When each litter averaged 68 kg, all pigs in the litter were probed for backfat. On the basis of a litters' average backfat probe, within each breed of sire, the litters were sorted into three lean and three fat litters. Within each of the lean and fat groups, the three litters were randomly assigned to slaughter weights of 100, 113 or 127 kilograms.

Pigs were weighed biweekly and pen feed consumption determined every 28 days for the first 112 days on test. After 112 days, pigs were weighed weekly, probed for backfat at 100 kg, and individually removed from the pen when their designated slaughter weight was attained. Total feed consumed from 112 days until the last pig was removed from the pen was also recorded. Pigs were slaughtered at the University Meat Laboratory for carcass evaluation.

All pigs were held off feed and water for 36 hr and final live weight (slaughter weight) was then recorded. Following slaughter, each side of the carcass was weighed and the right side was measured for length (distance from the first rib to the aitch bone) and average backfat thickness (average of measurements taken at the first and last rib and the last lumbar vertbra). *Longissimus* muscle area was obtained by the use of a planimeter on a tracing taken at the tenth rib interface.

After slaughter of the pigs produced in the 1975 fall season, the right half of each carcass was physically separated into lean, fat and bone. Both sides of the carcasses from pigs produced in the 1976 spring season were separated into closely trimmed lean cuts (shoulder, loin and ham). Percentage separable lean, fat and bone (1975 fall only) and percentage closely trimmed lean cuts (1976 spring only) of carcass weight were calculated.

Backfat thickness measured when the pigs were removed from test (off test backfat probe) was adjusted to the designated off test weight (100, 113 and 127 kg). Carcass backfat thickness, length and *longissimus* muscle area were adjusted to the mean slaughter weight of their designated slaughter group (94.6, 108.0 and 119.9 kg for the 100, 113 and 127 kg groups, respectively). The formula used for these adjustments is shown below.

$$\text{Adj. } Y_i = Y + \frac{Y}{b_0 + b_i(W)} b_1 (AW_i - W)$$

Where:

i is the designated slaughter group of the pig;

Y is the trait being adjusted;

b_0 and b_1 are the Y-intercept and slope from the regression of the trait on weight (off test weight for off test backfat probe and slaughter weight for carcass backfat, length and *longissimus* muscle area;

W is the weight of the pig (off test weight for off test backfat probe and slaughter weight for the carcass traits); and

AW_i is mean weight of the pigs in each classification by slaughter weight group (100, 113 and 127 kg for off test backfat probe and 94.6, 108.0 and 119.9 kg for the carcass traits). Values of b_0 and b_1 used to adjust these traits are presented in table 1.

Statistical analyses of data were performed on pen means. The experimental units (pens) were considered to be in a split-plot design of a 3 x 2 x 3 factorial arrangement of treatments. Breed group and degree of fatness (refers to the lean *vs* fat groups) are the main plot treatments and the designated slaughter weight is the sub-plot treatment. For all traits, except percentage separable lean, fat and bone and percentage closely trimmed lean cuts, the sums of squares and degrees of freedom were pooled

TABLE 1. COEFFICIENTS[a] USED TO ADJUST OFF TEST BACKFAT THICKNESS, CARCASS BACKFAT THICKNESS, CARCASS LENGTH AND *LONGISSIMUS* MUSCLE FOR WEIGHT

Trait	Coefficients b_0	b_1
Off test backfat probe, cm	.82	.021
Carcass backfat, cm	1.73	.011
Carcass length, cm	61.41	.185
Longissimus muscle area, cm^2	9.51	.213

[a]From the regression of each trait on weight.

within season. Protected least significant difference tests (Steel and Torrie, 1960) were used to compare means.

Results

When probed for backfat thickness at 68 kg, there was a .20 cm difference between the lean and fat groups (table 2). Although this difference is not as large as would be desired to determine if lean and fat pigs differ in growth and efficiency when fed to various weights, it was, however, large enough to effectively separate the pigs into lean and fat groups. Differences in backfat thickness probe between the lean and fat groups were .18 cm at 100 kg and .10 cm at off test weight (113.5 kg). Even though these differences appear small, the lean group had significantly less fat (3.1%) than the fat group.

Degree of fatness by slaughter weight interactions were nonsignificant for all traits except feed efficiency for the total test period; thus, all tables contain marginal means for weight group averaged over degree of fatness and for degree of fatness averaged over weight group.

Growth. Table 2 presents the means for growth traits and adjusted backfat probes. Although fat pigs tended to gain at a faster rate than lean pigs, average daily gain of the lean and fat pigs (.67 and .69 kg per day, respectively) for the total test period were not significantly different. Davey *et al.* (1969) and Hetzer and Miller (1972) also found gains to be similar among pigs from lines selected for high and low backfat thickness.

As slaughter weight increased from 100 to 127 kg, differences in average daily gain for the total period were nonsignificant. Many workers, including Wallace *et al.* (1959), McCampbell and Baird (1961), Buck (1963), Braude *et al.* (1963) and Skitsko and Bowland (1970) had found gains to be similar for swine carried to weights heavier than 100 kilograms, however, as weights of 100, 113 and 127 kg were obtained, backfat probe (2.92, 3.20 and 3.45 cm, respectively) increased significantly.

Average daily gain of pigs at two levels of fatness compared over specific age intervals are presented in figure 1. The first interval was from 63 to 91 days, the second from 91 to 119 days and continuing age to age intervals until the mean off test age of 210 days. Weight of the lean and fat groups is shown below the age of the pigs. Differences between fat and lean pigs at each age were nonsignificant. However, fat pigs consistently gained at a faster rate than lean pigs during the early stages of growth. Near the end of the test, lean pigs gained at a faster rate.

To better illustrate the gains of lean and fat pigs, figure 2 presents average daily gain measured over specific weight intervals. The first interval was from 15.4 to 31.7 kg, the second from 31.7 to 45.4 kg and continuing at 13.6 kg intervals to 127 kilograms. Again, differences at any point measured were nonsignificant. The fat group, however, gained at a faster rate to a weight of 86.2 kilograms. At weights beyond 86.2 kg, until 127 kg, gain of the fat group tended to decrease at a faster rate than gain of the lean group. At weights beyond 100 kg, the number of observations was decreased, resulting in larger standard errors.

Average daily feed consumption (figure 3) was measured over specific age intervals corresponding to those described previously. Differences between fat and lean pigs were nonsignificant at all times measured. However, fat pigs tended to consume more feed per day than lean pigs throughout the test period. Also, feed consumption increased as weight increased.

Feed efficiencies (expressed as kilograms of gain per kilogram of feed) measured over the same specific age intervals (figure 4) were essentially the same for both lean and fat pigs. This is in agreement with Davey *et al.* (1969), who found similar feed efficiencies in fat and lean pigs of Duroc and Yorkshire breeding. There was, however, a significant degree of fatness by weight interaction in feed efficiency for the total test. Feed efficiency for the fat 100, 113 and 127 kg groups were .323, .313 and .307 kg of gain per kilogram of feed, respectively, and the efficiency of the lean 100, 113 and 127 kg groups were .300, .310 and .312 kg of gain per kilogram of feed.

Feed efficiency decreased from .368 to .305 kg gain per kilogram of feed (averaged over lean and fat groups) from 28.6 to 84.4 kg live weight, respectively. From 84.4 to 100 kg pigs averaged .284 kg of gain per kilogram of feed, while the average was .257 kg gain per kilogram of feed from 100 kg to 113 or 127 kg live weight. Other workers, Wallace *et al.* (1959), McCampbell and Baird (1961) and Skitsko and Bowland (1970), have also found that pigs tended to become less efficient as heavier weights were obtained. Feed efficiency of pigs

TABLE 2. MEANS AND STANDARD ERRORS FOR LIVE ANIMAL BACKFAT ESTIMATES AND GROWTH TRAITS

Item	Degree of fatness		Slaughter weight, kg			Overall mean
	Lean	Fat	100	113	127	
No. of litters	18	18	12	12	12	36
Off test wt kg	113.4	113.6(±.06)	100.6^{a}	113.6^{b}	126.2^{c}(±.07)	113.5
Avg daily gain to 100 kg, kg	.653	.685(±.014)	.671	.662	.671(±.016)	.671
Avg daily gain for total test, kg	.667	.689(±.011)	.671	.667	.694(±.017)	.676
Adj. backfat probe at 68 kg, cm	2.16^{a}	2.36^{b}(±.025)	2.26	2.26	2.24(±.036)	2.26
Adj. backfat probe at 100 kg, cm	2.79^{a}	2.97^{b}(±.043)	2.92	2.90	2.82(±.071)	2.88
Adj. backfat probe off test, cm	3.15	3.25(±.043)	2.92^{a}	3.20^{b}	3.45^{c}(±.084)	3.20
Avg daily consumption for total test, kg	2.05	2.15(±.047)	2.06	2.04	2.20(±.066)	2.10

^{a,b,c}Different superscripts in a row, within each treatment, denotes significance at the $P<.05$ level.

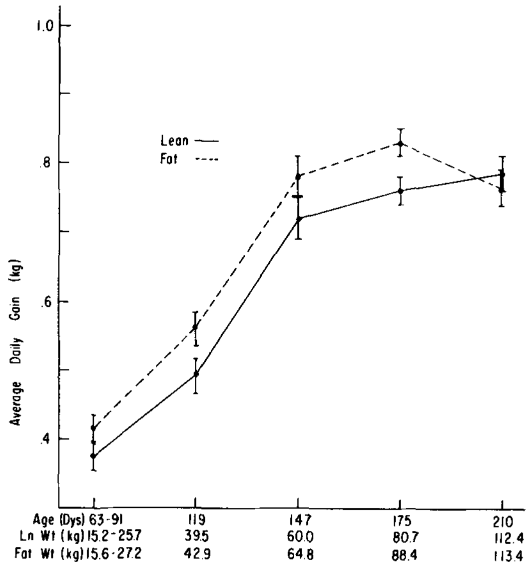

Figure 1. Average daily gain and their standard errors measured over specific age intervals beginning at 63 days of age.

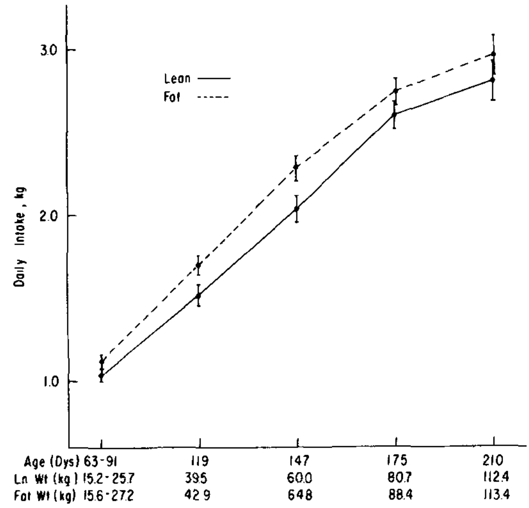

Figure 3. Average daily feed consumption and standard errors measured over specific age intervals beginning at 63 days of age.

to heavy weights in the present study, however, was better than that reported by other workers. From the average of five previous studies, Wallace *et al.* (1959), McCampbell and Baird (1961), Buck (1963), Braude *et al.* (1963) and Skitsko and Bowland (1970) a feed efficiency of 4.67 kg of feed per kilogram of gain (.214 kg gain/ kg feed) from 93 to 112 kg live weight has been obtained. Based on average backfat thickness of pigs in previous studies, pigs in the present study had considerably less fat. Growth rates, however, were similar. Perhaps the selection for decreased fat that has been practiced in the swine industry for several years has resulted in a leaner pig that grows more efficiently. Appetite also appears to be involved as daily feed consumption was less for the lean group than for the fat group.

Carcass Characteristics. Carcasses of fat pigs had virtually the same carcass weight, length and *longissimus* muscle area as lean pigs (table 3). This is contrary to the report of Hetzer and

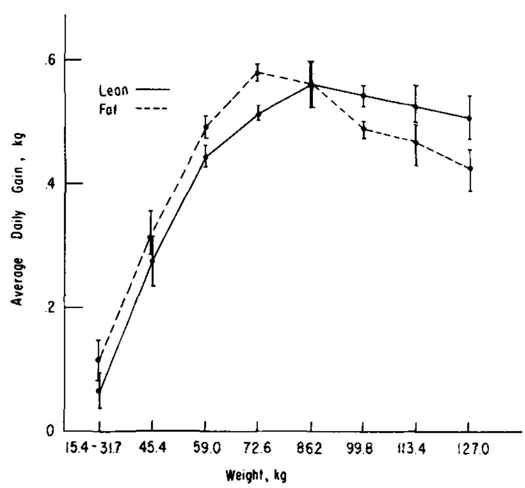

Figure 2. Average daily gain and standard errors measured over specific weight intervals beginning at 15.4 kilogram.

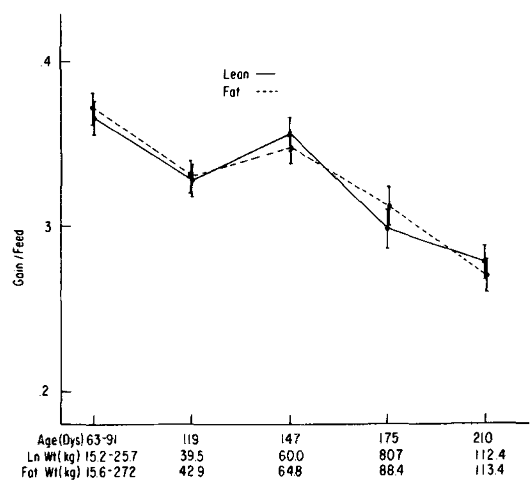

Figure 4. Feed efficiency (G/F) and standard errors measured over specific age intervals beginning at 63 days of age.

TABLE 3. MEANS AND STANDARD ERRORS OF CARCASS TRAITS OF SWINE AT TWO DEGREES OF FATNESS FED TO THREE WEIGHTS

Item	Degree of fatness		Slaughter weight, kg			Overall mean
	Lean	Fat	*100*	*113*	*127*	
No. of litters	18	18	12	12	12	36
Slaughter weight, kg	107.6	107.3 (± .6)	94.6[a]	108.0[b]	119.9[c](±.7)	107.5
Adj. carcass backfat, cm	2.82[a]	3.07[b](±.03)	2.79[a]	2.97[a,b,]	3.07[b,c](±.08)	2.95
Adj. carcass length, cm	81.0	81.5(±.25)	78.5[a]	81.8[b]	83.6[c](±.48)	81.3
Adj. *longissimus* muscle area, cm	32.6	32.6(±.19)	29.7[a]	33.1[b]	35.1[c](±.65)	32.6

[a,b,c]Different superscripts in a row, within each treatment, denotes significance at the $P<.05$ level.

TABLE 4. MEANS AND STANDARD ERRORS OF PERCENTAGE SEPARABLE LEAN, FAT AND BONE AND PERCENTAGE CLOSELY TRIMMED LEAN CUTS OF CARCASS WEIGHT

	Degree of fatness		Slaughter weight, kg			Overall mean
	Lean	Fat	100	113	127	
No. litters	9	9	6	6	6	18
Percentage lean[a]	57.2[c]	54.6[d](±.75)	55.6	56.3	55.8(±.92)	55.9
Percentage fat[a]	29.2[c]	32.3[d](±1.06)	31.0	29.9	31.3(±1.30)	30.8
Percentage bone[a]	13.6	13.2(±.33)	13.5	13.7	13.0(±.40)	13.4
Percentage closely trimmed lean cuts[b]	57.5	57.6(±.43)	58.2	58.0	56.4(±.53)	57.6

[a]Percentage separable lean, fat and bone from 1975 fall season pigs.

[b]Percentage closely trimmed lean cuts from 1976 spring season pigs.

[c,d]Different superscripts in the same row, within each treatment, denotes significance at the $P<.05$ level.

Miller (1973), who found smaller *longissimus* muscle areas in fat pigs than in lean pigs. Their study, however, evaluated carcasses produced from offspring at the end of 14 and 16 generations of selection for high and low backfat thickness. The difference in degree of fatness between the high and low fat lines was much greater than the difference between the fat and lean groups in the present study.

As slaughter weights of 100, 113 and 127 kg were obtained, carcass backfat thickness tended to increase linearly in (2.79, 2.97 and 3.07 cm, respectively). The 100 kg group had significantly less backfat than the 127 kg group. There were significant increases in carcass length and *longissimus* muscle area (78.5, 81.8 and 83.6 cm and 29.7, 33.1 and 35.1 cm^2, respectively) as slaughter weight increased. Buck (1963), Braude *et al.* (1963) and Skitsko and Bowland (1970) all reported increases in *longissimus* muscle area as slaughter weight increased beyond 100 kilograms.

During the first season of this study, percentage lean, fat and bone of the carcasses was obtained. The fat group, as shown in table 4, had 2.6% less lean and 3.1% more fat than the lean group ($P<.05$). Percentage bone was essentially the same in both groups.

As the pigs reached weights of 100, 113 and 127 kg, the percentage separable lean was similar (55.6, 56.3 and 55.8%, respectively). Percentage fat and bone were also similar (31.0, 29.9 and 31.3% and 13.5, 13.7 and 13.0%, respectively) as slaughter weight increased. Many workers, including Cuthbertson and Pomeroy (1962), Buck (1963), Braude *et al.* (1963) and Richmond and Berg (1971), have reported decreased percentage lean and increased percentage fat in carcasses at heavy slaughter weights. Pigs in the present study were considerably less fat than those of previous studies which may explain part of this discrepancy.

In the second season carcasses were evaluated for percentage closely trimmed lean cuts. The lean and fat groups were not significantly different for percentage closely trimmed lean cuts (57.5 and 57.6%), as shown in table 4. However, the 100 and 113 kg groups had similar percentages trimmed lean cuts (58.2 and 58.0%), whereas the 127 kg group tended to have a slightly lower percentage (56.4%).

Conclusion

Growth rates increased in a linear fashion from about 15 to 75 kg, but declined slightly from 75 to 127 kilograms. Gain per kilogram of feed, however, declined steadily as weight increased. Lean and fat groups tended to have similar growth patterns. As slaughter weight increased, carcass length, backfat thickness and *longissimus* muscle area increased; but percentage lean, fat and bone in the carcass changed very little. These data indicate that carcass value should be similar for pigs slaughtered at weights between 100 and 127 kilograms. The decrease in feed efficiency as weight increases would be the most important factor in determining optimum slaughter weights.

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